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EFFECTS OF BRIGHT ILLUMINATION ON ORAL TEMPERATURE AND COGNITIVE PERFORMANCE IN HUMANS DURING NIGHTTIME HOURS

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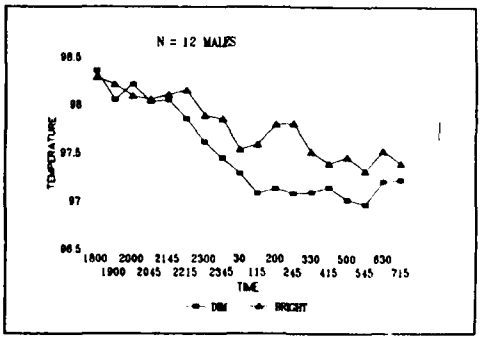
The objective of this study was to compare the effects of bright and dim illumination on sublingual temperature and behavioral measures to determine if illumination treatment can reduce fatigue and enhance human work performance during specific evening and nighttime periods. Lighting levels for work are typically task specified for actual optimal visual stimulation without considering potential biological and behavioral effects of the light stimuli. This research effort investigated the possibility that human performance may be less than optimal under the 50 to 500 lux light environment that is typical of many work station settings and that performance may be improved under bright wide spectrum illumination.

Methods: Twelve healthy "pilot rated" male subjects, ages 21-29 were recruited from Senior Officer Cadets enrolled in the Air Force ROTC Program at Northern Arizona University. Subjects were instructed to refrain from all medications, alcohol, and caffeine stimulants for 72 hours prior to an experimental session. Finally, subjects were asked to stay up 2 hours past their normal bedtime on the night before each testing night. Subjects awoke between 0600 and 0700 hrs the day of testing and spent the entire day awake before reporting to the laboratory at 1700 hrs.

Subject preparation began at 1700 hrs with training and stabilization scheduled from 1800 hrs to 2400 hours. A dim baseline illumination (50 lux Vita-lite, Duro-test Corp.) was maintained from 1800 hrs through 2100 hrs in both treatment conditions. Subjects were exposed to the 2 lighting conditions in a counter-balanced design (minimum 2 weeks between conditions) to evaluate a) order of presentation effects b) time point effects and c) illumination condition (bright v. dim) effects across the 5 respective measurement periods from 0030 hrs through 0800 hrs. On one night, subjects were exposed to bright wide spectrum illumination (5000 lux Vita-lite) from 2100 hrs to 0800 hrs. On the other night, subjects were exposed to the 50 lux illumination condition throughout the night. Sublingual temperature was measured using a Revco Digital thermometer every 45 minutes commencing at 1800 hrs. The test battery of cognitive performance measures were administered every 1.5 hrs and consisted of selected tests from the Walter Reed Performance Assessment Battery (WRPAB) and the Complex Cognitive Assessment Battery (CCAB). The setting consisted of a PC work station under a large 3 articulation light fixture which permitted precise overhead fixture placement for each subject. Social interaction was minimized by testing only one subject each night and by the demands of the experimental protocol.

Results: A repeated measures 3-way ANOVA indicated that subjects' oral temperatures were significantly higher during exposure to bright light compared to dim light from 2100 hrs to 0800 hrs, $p < .001$ (see Figure below). Main effects for the cognitive measures were analyzed with a repeated measures 3-way ANOVA. Order of illumination treatment effects were absent for data in both the WRPAB and CCAB. The bright illumination condition favored speed and speed x accuracy on 4 of the 29 dependent variables $p < .02$ on the WRPAB. Specifically, bright light favored serial addition speed ($p = .001$) and speed x accuracy ($p = .001$) and code substitution speed ($p = .003$) and speed x accuracy ($p = .016$). Twenty of the remaining 25 variables favored bright illumination, but did not meet the required $p < .05$ alpha level for statistical significance. Results for the CCAB also indicated a trend toward a light effect with 66% of the measures favoring bright illumination. None of the CCAB measures were statistically significant at the $p < .05$ alpha level. **Conclusions:**



The effect of bright wide spectrum light upon the sublingual temperature circadian marker is pronounced. This relative elevated oral temperature is accompanied by improved performance on some cognitive performance measures from 0030 through 0800 hrs. Work that demands vigilance and is monotonous may be especially sensitive to lighting effects during nighttime hours. These findings are of potential value in optimizing environments for individuals with extended work/rest cycles such as civilian shift workers, military personnel and astronauts.

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